CYCLOPYGID TRILOBITES FROM GIRVAN

AND A NOTE ON *BOHEMILLA*

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Pp. 305–324; *Pls.* 32, 33

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
GEOLOGY Vol. 1 No. 10
LONDON : 1952

THE BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), *instituted in 1949, is issued in five series, corresponding to the Departments of the Museum.*

Parts appear at irregular intervals as they become ready. Volumes will contain about three or four hundred pages, and will not necessarily be completed within one calendar year.

This paper is Vol. 1, No. 10, of the Geological series.

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

Issued October 1952 *Price Six Shillings*

CYCLOPYGID TRILOBITES FROM GIRVAN AND A NOTE ON *BOHEMILLA*

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SYNOPSIS

Two new genera and two new species belonging to the Cyclopygidae are described. The genus *Bohemilla* is here excluded from the Trilobita on account of certain exoskeletal details.

Mr. Ronald Tripp in re-examining the trilobite fauna from the Whitehouse Beds of Girvan, Ayrshire, as represented in the Gray Collection now in the British Museum, recognized several cranidia (attributed in manuscript by Reed to '? *Bohemilla*') as possibly belonging to *Phylacops*. He arranged for these specimens to be forwarded to me for study and, meanwhile, Mr. R. Baker was successful in finding in the unexamined material of the Gray Collection not only many better preserved specimens but also another new cyclopygid genus collected on the foreshore at Shalloch Mill.

Bohemilla is an exceptional and challenging fossil which is detached taxonomically from the cyclopygids, but a study of its morphology was clearly necessary since some workers had detected similarities between these arthropods.

Few monographs on fossils are written nowadays without help from other palaeontologists, and this short paper is no exception. Mr. R. Tripp was instrumental in directing my attention to some of the Girvan material I have described; Mr. R. Baker, Mr. A. G. Brighton, and Dr. J. C. Harper provided me with the opportunities for examining specimens in their charge; Professor H. B. Whittington and Dr. F. Prantl rendered valuable assistance by sending me photographs of type-specimens; Dr. C. J. Stubblefield and Dr. H. E. Hinton have discussed the structure and affinities of some of the fossils; Dr. Stanley Smith has derived the new generic names proposed in the text; and Mr. E. W. Seavill has prepared the photographs of the figured specimens from Britain.

The following abbreviations denote the museums in which the specimens are housed: BM: British Museum (Natural History); GSM: Geological Survey and Museum; MCZ: Museum of Comparative Zoology, Harvard; NM: Narodni Museum, Prague.

Family CYCLOPYGIDAE Raymond 1925

More than seventy years ago Nicholson & Etheridge (1880: 287) realized that the species of *Cyclopyge* known to them from Girvan could readily be separated into three distinctive groups, and they prophesied that in due course each would be accorded generic rank. *Cyclopyge* has been retained for the species comprising one of these groups, genotype *Cyclopyge rediviva* (Barrande, 1846: 34), wherein the large faceted eyes are developed as separate structures. In *Symphysops*, genotype *Symphysops armatus* (Barrande) (Raymond, 1925: 64), and *Phylacops*, genotype *Phylacops*

vigilans (Cooper & Kindle, 1936: 366), the eyes are united anteriorly into a single element, but *Symphysops* is distinguished by the glabella being prolonged into a frontal spine. Two new genera, *Psilacella* and *Ellipsotaphrus*, are now added to the family.

Genus ***PSILACELLA***[1] nov.

Diagnosis. Glabella occupies most of the cranidium, carries three pronounced furrows; occipital ring absent. Fixed cheeks narrow and exceedingly small; axial furrow weak and continues as the preglabellar furrow. Facial sutures, probably confluent to form semi-elliptical outline, cut the posterior border close to the axial furrow; traced anteriorly they delimit, as far as the notch in their outline opposite the second glabellar furrow, the narrow and parallel-sided fixed cheeks, beyond which they form the edge of the brim passing round the outside of the preglabellar furrow. Multifaceted eyes assumed to unite anteriorly to form a single visual organ. Free cheeks unknown. Thorax unknown.

Pygidium sub-semicircular in shape; axis half pygidial length, carries five axial rings; three pairs of pleurae present and pleural lobes smooth posterolaterally.

Type species. Psilacella trirugata sp. nov.

Horizon and localities. Ordovician, Upper Whitehouse Beds, Ashgill Series: Whitehouse Bay and Shalloch Mill, Girvan, Ayrshire.

Psilacella trirugata sp. nov.

(Plate 32, figs. 1–5)

Diagnosis. As for genus.

Description. The new species is represented by three cranidia, two faceted eyes, and one pygidium, at one time all preserved on the same slab of mudstone where they were associated with a pygidium of the rare *Cyclopyge bumasti* Reed (BM: In. 44010, In. 44098–44100). The two isolated eyes may conceivably belong to the latter species, but one of the specimens shows the left eye extending sufficiently near to the mid-line as to suggest that the paired eyes approached close to one another around the front of the cephalon; assuming the correctness of this statement, this eye could not belong to *Cyclopyge bumasti*, and it is attributed to *Psilacella* which is the only other associated cyclopygid. One further cranidium, from Whitehouse Bay, is available (BM: In. 37090).

The cranidium of the holotype (BM: In. 44010) is strongly convex, 5·5 mm. in breadth and length, and ornamented with a delicate granulation which may be due more to peculiarities of preservation than to the structure of the exoskeleton. There is no occipital ring, apparently the posterior border furrow is absent and the fixed cheeks are minute; consequently the glabella constitutes most of the cranidium. None of the three pairs of furrows extends across the glabella and the space between each pair increases, the interval being about one-quarter of the glabellar breadth posteriorly and about one-third in the anterior pair. The second and posterior pairs

[1] Ψιλάξ, one who is bald.

of furrows run subparallel to the posterior border, but the anterior furrows pass obliquely forwards and inwards, and externally converge towards the second furrows. A narrow and gently concave fixed cheek, separated from the glabella by a feeble axial furrow, reaches from the posterior margin as far forward as the second glabellar furrow where there is a slight notch in the outline of the cranidium. Beyond this notch, which may mark the position of the hinder end of the faceted eye, the axial furrow continues as the preglabellar furrow and is attended externally by an exceedingly narrow flat brim.

The lateral and front margins of the cranidium are well preserved not only in the holotype but also in one of the paratypes; thus the course of the facial suture can be determined. The suture commences at the posterior margin about 0·3 mm. outside the axial furrow, passes straight forwards, and delimits a fixed cheek which is so small as to be almost non-existent, forms a slight notch opposite the second glabellar furrow, thence runs outside the brim bordering the preglabellar furrow and is confluent with the facial suture of the opposite side; the facial sutures are interpreted as a single structure for which there is no obvious indication of a dual origin. The eye is provided with numerous facets of the normal cyclopygid pattern. One specimen (BM: In. 44100) is exceedingly difficult to interpret, but it is thought to represent the ventro-lateral aspect of a left eye squashed against the under surface of the cranidium; the outer margin of the specimen is a broken edge leading inwards to a narrow area, with terraced lines, which is prolonged into what simulates a spine but is probably nothing more than a trick of preservation. The inner margin of the eye is sigmoidal in form where it abuts against a concave surface, possibly to be identified as the rostral plate; the faceted region decreases in area when traced inwards and in front of this plate, and the general appearance suggests the eyes might be fused into a single visual organ.

The thorax is unknown.

The pygidium is almost twice as broad as long, and smoothly rounded in outline. The axis, which is slightly less than half the pygidial breadth measured along the anterior border, has the shape of a broad-based, inverted, stumpy triangle reaching posteriorly just beyond the mid-pygidial length, is well defined by axial furrows, and carries five clearly differentiated axial rings. Three pairs of pleurae alone can be detected, the postero-lateral portions of the pleural lobes being smooth; there is no postaxial ridge. The inclination of the border appears to change from vertical, posteriorly, to nearly horizontal, anteriorly, and it terminates behind the anterior pleurae which extend to the margin; a marginal furrow is present. The antero-lateral corners are sharply angular in outline, and here triangular facets are delimited by a deep furrow which is an extension of the furrow behind the articulatory half-ring.

Horizon and localities. Ordovician, Upper Whitehouse Beds, Ashgill Series: exposed on the foreshore at Whitehouse Bay and near Shalloch Mill, Girvan, Ayrshire.

Holotype. BM: In. 44010.

Other Specimens. BM: In. 37090, In. 44098–44100.

Discussion. The three paired glabellar furrows readily separate the new genus from *Phylacops vigilans* of the Whitehead Formation of Upper Ordovician (? Richmondian) age of Percé, Quebec (Cooper & Kindle, 1936: 367, pl. 52, figs., 36, 39,

41–51), and from *P. mirabilis* of the Portraine Limestone of Ashgill age of co. Dublin, Éire (Salter, 1853, pl. 10, figs. 1–7),[1] because these species are distinguished by one pair of lateral furrows. The Upper Tirnaskea Beds of Ashgill age, Zone of *Dicellograptus anceps*, of Pomeroy, Éire, contain cyclopygids which were first recorded as *Aeglina rediviva* (Fearnsides & others, 1907: 123, pl. 8, figs. 14–16). The fauna has recently been re-examined and one of the cyclopygids (Sedgwick Museum A. 16373) has been identified by Reed (in the press) as *P.* cf. *vigilans*. This specimen differs from *Psilacella trirugata* in the segmentation of the glabella and in the proportions of the pygidium and its axis.

The need for the new generic name of *Psilacella* was not determined until comparisons were made with the known species of *Phylacops* and also with certain trilobites from Bohemia; the latter appear to be most fittingly placed in *Phylacops* and this genus assumes a greater geographical distribution than was previously known. In their diagnosis for *Phylacops* Cooper & Kindle (1936: 366) mention that the eyes meet in front of the glabella, and elsewhere quote Nicholson & Etheridge (1880: 287) who, referring to *Cyclopyge mirabilis*, state that the eyes are 'united in front of the head to form one large optical organ'. Cooper & Kindle include *C. mirabilis* in *Phylacops*; in the photographs of the lectotype reproduced on Pl. 32, figs. 6–8, the binary origin of the eye is clearly shown in anterior view, where a shallow median groove, which is straddled by the facets, separates it into halves.

Klouček gave the briefest of descriptions, without illustrations, of two varieties of '*Aeglina*' wherein the eyes approach one another so closely, anteriorly, that they are separated by no more than a narrow band devoid of facets. One of these varieties recorded by Klouček (1919: 243, NM: CD 518) as *Aeglina speciosa* var. *synophthalma* was renamed for nomenclatorial reasons by Richter (1937: 301) as *Cyclopyge speciosa* var. *kloučeki*. This variety is so obviously different from *C. speciosa* (Barrande) that it should be given specific rank. The large size of the eyes and their extension around the glabellar front preclude the retention in *Cyclopyge*, and there appears to be no sound argument against including the species in *Phylacops* unless it be the presence of an unfaceted narrow strip separating the eyes (Pl. 32, fig. 9). For the present, therefore, *C. kloučeki* from the Svata Dobrotiva Shales of Malé Přilepy, near Beroun, central Bohemia, is placed in *Phylacops*. The shales are probably of Llandeilo age and correspond to the $d_{\gamma 2}$ horizon. The notation adopted here was suggested by Kettner & Kodym (1919)[2] and has been employed by most subsequent authors (Heritsch, 1928: 331; Kettner & Bouček, 1936, table IV). There have been several modifications, attended by some confusion, of the original notation proposed by Barrande, who used $Dd_{1\gamma}$ for the Osek and Kváň Beds and these include the well-known deposits of Šárka and Svata Dobrotiva. Klouček (1909), on the evidence of trilobites, subdivided the $d_{1\gamma}$ beds into $d_{1\gamma a}$ and $d_{1\gamma b}$, and these Kettner and Kodym relettered $d_{\gamma 1}$ and $d_{\gamma 2}$. The Šárka Beds ($d_{\gamma 1}$) are to be correlated with the zones of *Didymograptus bifidus* and *D. murchisoni* of Britain, and Bouček (1926: 542) suggests that the topmost horizon which yields *D. murchisoni* var. *clavulus* may even range

[1] *P. mirabilis* is usually attributed to Forbes; it was, however, first described by Salter who used Forbes's manuscript name.

[2] Reference is unverified as no copy of this publication has been traced.

into the Llandeilo (Zone of *Glyptograptus teretiusculus*).[1] The stratigraphically higher Svata Dobrotiva Beds ($d_{\gamma 2}$) accordingly are tentatively correlated with the Llandeilo Series, not because they yield graptolites of correlation value, but because they are succeeded by the Drabov Quartzite (d_{δ} beds), and these are followed by the Zahořany Beds (d_{ϵ}) which have produced graptolitic evidence for the presence of the Zones of *Dicranograptus clingani* and *Pleurograptus linearis* (Heritsch, 1928: 332; Bouček, 1928: 394).

Klouček (1919: 239, NM: CD 520) also records *Aeglina prisca* var. *synophthalma* from the Llanvirn Beds of Šárka ($d_{\gamma 1}$) and his short description of the eyes agrees almost word for word with that given by him for *P. kloučeki* (Richter). If the latter species is properly placed in *Phylacops* then the Llanvirnian form should be raised to specific level, because it is not a variety of *Cyclopyge prisca* (Barrande); it is here recorded as *Phylacops synophthalmus* (Klouček). The inclusion of the two Bohemian species in *Phylacops* gives the genus a larger stratigraphical range from Llanvirn to Ashgill and a wider geographical distribution than it was formerly thought to possess.

Genus *ELLIPSOTAPHRUS*[2] nov.

Diagnosis. Cephalon subquadrate with rounded anterior outline; axial furrows diverge slightly from posterior border, thence sweep inwards meeting at mid-line in extremely obtuse angle: two glabellar furrows, the posterior entire and the anterior discontinuous and paired: occipital furrow[3] entire, merges into axial furrows to form with them and with the preglabellar furrow a ring-shaped groove: occipital ring strong and tumid. Fixed cheeks small, narrow, reach back to posterior border without pleuroccipital furrow, extend forwards for about one-third total cephalic length where they are confluent with a narrow brim running round the front of the glabella. The facial suture cuts the posterior margin 1 mm. outside the axial furrow, swings for a short distance slightly inwards and then markedly outwards nearly as far as the level of the second glabellar furrow, beyond which it curves inwards to meet the suture on the opposite side in an obtuse angle. Eyes coarsely multifaceted, fused into single element with no anterior median groove marking the line of fusion, concavo-convex in dorsal view, semicircular in outline on convex side.

Thorax incompletely known: axis broad, number of axial rings unknown but not less than four or five: pleurae short, bluntly terminated, each carries a pleural furrow.

Pygidium is known only in a crushed and downturned condition. Unfortunately the details cannot satisfactorily be determined, but the pygidium is apparently short relative to breadth, one pronounced ring can be detected on an axis which is

[1] Hede (1951: 54 and Table 5 facing p. 70) correlates the zone of *Didymograptus clavulus* of the Upper Didymograptus Shales of Sweden with the upper part of the Llanvirn.

[2] ἔλλειψις, ellipse, and τάφρος, ditch, allude to the characteristic form of the composite furrow surrounding the glabella.

[3] The interpretation of the posterior portion of the cephalic axis is difficult; either an occipital ring is present in the genotype, in which case the pleuroccipital furrow is absent on the fixed cheek, or the occipital ring is absent and the glabella extends to the posterior border. The former reading of the structure is followed here because what is probably a pleuroccipital furrow is found in *E. pumilio* and *E. infaustus* which otherwise closely resemble *E. monophthalmus*.

about one-fifth the pygidial breadth, the anterior pleural border is tumid and succeeded posteriorly by a deep furrow, and there is one furrow on each pleural lobe.

Type species. *Ellipsotaphrus monophthalmus* (Klouček).

Horizon and localities. The Svata Dobrotiva Shales probably of Llandeilo age ($d_{\gamma 2}$)[1] exposed in the brickyard in Prague XIX—Šárka (Vokovice), Bohemia (genoholotype); *Didymograptus bifidus* beds: Shropshire (Hope Shales), and near Llanfallteg railway station, Pembrokeshire.

Discussion. The diagnosis has been constructed from photographs of the holotype of *E. monophthalmus* from Bohemia (NM: CD 513; Pl. 32, figs. 10, 11), from Klouček's restoration of the cephalon (1919: pl. 1, figs., 4–6, reproduced here Pl. 32, figs. 12–14) and from several specimens collected from the *Didymograptus bifidus* beds of west Shropshire (Hope Shales) and of Pembrokeshire which show the indifferently preserved thorax associated with the cranidium (Whittard, 1940: 137, pl. 6, figs. 1–3); one specimen from Shropshire and another from Pembrokeshire are refigured for comparison with the genoholotype from Bohemia (Pl. 32, figs. 15, 16).

In 1940 I included *E. monophthalmus* in the then recently described *Phylacops* because, unlike any other cyclopygid genus, the paired eyes are completely fused into a single organ, but it is now realized that differences in the morphology of the glabella are sufficiently pronounced to be of generic, rather than specific, importance; for this reason the new genus *Ellipsotaphrus* has been named for the reception of *E. monophthalmus* and of two other, but stratigraphically younger, Ordovician species which appear to be closely related.

Ellipsotaphrus pumilio sp. nov.

(Plate 33, figs. 1–3)

Diagnosis. Elliptical glabella possesses two furrows of which the anterior one is discontinuous; occipital ring not defined laterally by axial furrows; pleuroccipital furrows present but short. The combined facial sutures are semi-elliptical in shape; eyes assumed to be merged into a single organ.

Description. The cranidium varies in size, the smallest measuring 2·3 mm. long and 3 mm. broad, and the largest 3·8 mm. by 4·8 mm. The cranidium has generally been distorted during preservation, but in a few compressed specimens the glabella is surrounded by a composite furrow, ellipsoidal in shape, which immediately recalls the ring-shaped groove of *E. monophthalmus*. Like that species the glabella exhibits two furrows; the posterior one is complete and transverse, and the anterior is discontinuous over the mid-third of the glabellar breadth. The preglabellar, axial, and occipital furrows are interpreted as a confluent, ring-shaped groove. The occipital ring is indicated by the posteriorly convex portion of the hinder cranidial margin, but it is not delimited laterally by the axial furrows which do not continue behind the occipital furrow. The postero-lateral area existing outside the axial furrow and the occipital ring is divided into two portions by a short, horizontal, pleuroccipital furrow which, losing depth as traced inwards from the external margin, vanishes before the inferred lateral edge of the occipital ring is reached; the anterior portion,

[1] See page 310 for a note regarding the correlation of these deposits.

of crescentic shape, is identified as the fixed cheek and is separated along the length of the short pleuroccipital furrow from the almost parallel-sided posterior border.[1] The anterior border of the fixed cheek is occasionally seen to be feebly notched just in front of the level of the posterior glabellar furrow, indicating possibly the position of the backward extension of the eyes. The outline of the cranidium is preserved in several individuals and this shows the trend of the facial sutures; in combination, these sutures have the general form of an inverted horseshoe. The eyes are assumed to be fused or conjoined, although in the thirty specimens studied no cyclopygid eye-pattern has been detected in contact with the cranidium, but neither has it been observed in the British specimens of *E. monophthalmus*. A narrow brim, commencing at the position of the paired anterior glabellar furrow, extends round the front of the glabella.

Horizon and locality. Ordovician, Upper Whitehouse Group, Ashgill Series: Whitehouse Bay, Girvan, Ayrshire. *E. pumilio* is associated with a rich trilobite fauna including *Agnostus 'perrugatus'* Barrande, *Ampyx* (*Lonchodomas*) *portlocki* Barrande, *Cyclopyge rediviva* (Barrande), *Dionide lapworthi* Nicholson & Etheridge, *Lichapyge? problematica* Reed, *Symphysops subarmatus* (Reed), *Shumardia scotica* Reed, and *Bohemilla scotica* Reed.

Dr. J. C. Harper sent me the cyclopygids collected by him from co. Clare, where, as at Girvan, they are associated with *Bohemilla* (Stubblefield, 1939: 61), and from co. Louth, Éire, but nothing resembling *Ellipsotaphrus* was detected.

Holotype. BM: In. 41750.

Other Specimens. BM: In. 21691, In. 21696, In. 44001.

Discussion. The labels accompanying two specimens (BM: In. 21691 and In. 21696) state that they are syntypes of *Bohemilla scotica* as selected by Reed (1904: 53 and 1914: 22); he failed, however, to separate what is now described as *E. pumilio* from *Bohemilla* and these two syntypes definitely belong to the new species

E. pumilio is distinguished from *E. monophthalmus* by the absence of axial furrows at the sides of the occipital ring and by the development of the pleuroccipital furrows; otherwise there is little detail on which to separate them.

Ellipsotaphrus infaustus (Barrande)

(PLATE 33, FIGS. 4, 5)

1852 *Trilobites infaustus* Barrande, p. 915, pl. 34, fig. 45.
1919 *Trilobites infaustus* Barrande: Klouček, p. 243.
1940 *Phylacops infaustus* (Barrande) Whittard, p. 138.

The only known specimen (NM: CD 855), preserved as an external mould in a soft black shale, is a subquadrate cranidium 4 mm. long and 4·8 mm. in maximum breadth. The glabella conforms to the generic pattern, both in shape and segmentation, but the occipital and axial furrows meet at an obtuse angle instead of flowing into a continuous curve. The occipital ring is pronounced, longest in the mid-line where it is also markedly convex in posterior outline, but the photograph submitted by

[1] The terminology used for the parts of the posterior region of the cranidium is open to criticism, as also is the case in *E. monophthalmus* and *E. infaustus*, but the morphological arrangement is anomalous and unlike any other trilobite known to me.

Dr. Prantl (Pl. 33, fig. 4) does not show the axial furrows extending to the back border of the crandium. The fixed cheek is triangular, and the base is defined by the pleuroccipital furrow; the apex projects to a position midway between the two glabellar furrows, from whence a narrow brim sweeps forwards and inwards around the glabellar front, meeting its fellow medially in an almost continuous curve, but, as in *E. monophthalmus*, there is a slight angularity here in the outline. The margin of the cranidium appears to be undamaged and may be assumed to indicate the course of the facial sutures which is similar to that of *E. pumilio*; the eye is unknown.

Horizon and locality. Barrande did not specify the horizon of the holotype more fully than Étage D, and the locality is given by him as near Trubin in the neighbourhood of Beroun, Bohemia. Dr. Prantl has written to say that the specimen was obtained from the Cernin Beds ($Dd_{\epsilon 2a}$), which are to be correlated with the Caradoc Series according to Kettner & Bouček (1936, table IV).

Holotype. NM: CD 855.

Discussion. The many resemblances between *E. monophthalmus* and *E. infaustus* led me (1940: 138) to believe the species might be synonymous, particularly in view of the uncertainty whether the lobe-like structure in the postero-lateral corner of Barrande's figure was really a portion of the fossil. In a personal communication Dr. Prantl remarks that Barrande's figure is a faithful portrayal of the holotype; *E. infaustus* can thus be separated on the failure of the axial furrow to attain the posterior border and on the presence of the pleuroccipital furrow. *E. infaustus* is, however, even closer to *E. pumilio* which, apart from being much smaller, apparently differs only in the incomplete pleuroccipital furrow and in the extension of the fixed cheek farther inwards behind the glabella.

CYCLOPYGID PYGIDIA

More than twenty detached cyclopygid pygidia, which cannot confidently be matched with any described members of the family, are associated with the cranidia of *Ellipsotaphrus pumilio*. Ranging from 2 to 4·5 mm. in breadth, at least four different kinds are recognizable, including some which are larval stages, and, as on the same slab of rock two or three kinds may occur adjacent to a cranidium of *E. pumilio*, there is at the moment no means to determine without dubiety which pygidium belongs to this species. One is similar to *Cyclopyge rediviva* and another to *Symphysops subarmatus*, and these are the only cyclopygids described by Reed from the particular rocks yielding *E. pumilio*; the remaining two kinds of pygidia are larval stages but do not belong to the same species.

Pygidium A

(Plate 33, fig. 6)

The pygidium (BM: In. 42539) is 4·7 mm. broad and 3 mm. long, the margin is smoothly rounded, and the anterior border is raised and succeeded posteriorly by a transverse groove. The axis is strongly defined by axial furrows, is one-half the length and a little more than one-quarter the breadth of the pygidium, and carries four rings which are terminated posteriorly by a conically shaped area. Three pairs

of pleurae are well defined, there being at least two additional pairs although these are but faintly indicated; pleural furrows are moderately impressed and apparently extend outwards to the incompletely preserved margin. The axial furrows are in continuation posteriorly with a median postaxial furrow.

The presence of pleural furrows and, so far as can be determined, the absence of a marginal furrow, superficially distinguish the pygidium from that of *Symphysops subarmatus* (Reed, 1914: 21, pl. 3, fig. 9); but pygidium *A* is much smaller than the type of *S. subarmatus* and these small differences may be attributed to changes accompanying growth.

Horizon and locality. Ordovician, Upper Whitehouse Beds, Ashgill Series: Whitehouse Bay, Girvan, Ayrshire.

Pygidium B

(Plate 33, fig. 7)

The pygidium (BM: In. 21701) is 3 mm. broad and 2 mm. long, semi-elliptical in shape; there is no lateral marginal furrow, and the anterior border is convex and marked posteriorly by a transverse furrow. The axis, which is half the length and slightly in excess of quarter the breadth of the pygidium, shows two strong rings and a conical terminal piece; a minimum of two pairs of pleurae, without pleural furrows, are present and additional pairs are vaguely outlined.

The specimen recalls the pygidium of the complete individual of an immature *Cyclopyge rediviva* (Barrande) figured by Reed (1904, pl. 8, fig. 2); a comparison of Barrande's and Reed's illustrations throws doubt on the correctness of Reed's identification because of the disparity in the details of the pygidia, in the number of thoracic segments (which may be due to a meraspid condition), and in the illaenid-like cephalon.

Horizon and locality. Ordovician, Upper Whitehouse Beds, Ashgill Series: Whitehouse Bay, Girvan, Ayrshire.

Pygidium C

(Plate 33, figs. 8, 9)

A diminutive pygidium, which is as broad as long and measures 2 mm. along the anterior border, is parallel-sided and rounded posteriorly (BM: In. 44006); the anterior border is raised, separated posteriorly by a transverse furrow, and the edges corresponding to the front of the pleural lobes are deflected in comparison with the articulatory surface of the axis. The well defined axis is about two-thirds the length and a little less than one-third the breadth of the pygidium, and carries five pronounced rings; five ungrooved pleurae almost attain the margin. The postaxial surface is smooth and axe-head in shape.

The pygidium is preserved close alongside a cranidium of *Ellipsotaphrus pumilio* and the proportions are consistent with them being parts of the same animal; the cranidial breadth is no more than a third of the measurement taken from the largest known specimens of *E. pumilio*, and it may be a larval form.[1] The number of pleurae

[1] If this interpretation is correct, the characteristic details of the more mature cranidium have already appeared.

relative to the pygidial size is also indicative of a young stage and it is probably a 'transitory pygidium'.

A slightly larger specimen (BM: In. 44110; Pl. 33, fig. 9) measuring 2·5 mm. across the front is obviously closely similar to the pygidium already described, but there are now four axial rings and four pleurae on each side; a shallow marginal furrow delimits a marginal border.

Horizon and locality. Ordovician, Upper Whitehouse Beds, Ashgill Series: Whitehouse Bay, Girvan, Ayrshire.

Pygidium D

(Plate 33, fig. 10)

This type of pygidium is broader than long, measurements for two examples being 2 mm. and 3 mm. broad with corresponding lengths of 1·7 mm. and 2·3 mm., but otherwise there is a similarity with the outline of pygidium *C* particularly in respect to the subparallel sides. The broadly based axis possesses nine rings in the smallest pygidium (BM: In. 44000) and eight in the largest (BM: In. 42548); both show five unfurrowed pleurae and probably there are one or two further pleurae, but these are ill defined. A narrow border and a faintly impressed border furrow are present.

The larval pygidium *D* recalls pygidium *A* which is attributed provisionally to *Symphysops subarmatus*.

Horizon and locality. Ordovician, Upper Whitehouse Beds, Ashgill Series: Whitehouse Bay, Girvan, Ayrshire.

INCERTAE SEDIS

Family BOHEMILLIDAE Barrande 1872

Klouček recognized certain similarities between *Bohemilla* and *Ellipsotaphrus infaustus*, and Reed attributed many specimens in the Gray Collection to *Bohemilla*, although most of these are now known to belong to *E. pumilio*. All the specimens of *B. stupenda* studied by Barrande are in the Schary Collection of the Museum of Comparative Zoology, Harvard, and I am obliged to Professor Whittington for sending me stereoscopic photographs of each; Dr. Prantl has also forwarded a photograph of the specimen described by Klouček. I have failed to determine the taxonomical relationships of this unusual arthropod, but the genus has been reviewed and Barrande's interpretation of the morphological structure vindicated.

Genus ***BOHEMILLA*** Barrande 1872

Bohemilla stupenda Barrande

(Plate 33, figs. 11, 12)

1872 *Bohemilla stupenda* Barrande, p. 137, pl. 14, figs. 30–31 *non* fig. 32.
1896 *Aeglina stupenda* (Barrande) Beecher, p. 360, figs. 1–3.
1897 *Aeglina stupenda* (Barrande): Holm, p. 457.
1907 *Bohemilla stupenda* Barrande: Zelizko, p. 218.
1918 *Bohemilla stupenda* Barrande: Novák & Perner, p. 51.

1919 *Bohemilla stupenda* Barrande: Klouček, p. 244, fig. 10.
1923 ? *Bohemilla stupenda* Barrande: Klouček, p. 9, text-fig.

In his description of this bizarre arthropod Barrande used the specimen (MCZ: 4404) here selected as the lectotype, because this is the only specimen showing the posterior portion of the exoskeleton. The head-shield is composed of a median segmented region, 12 mm. long and 11 mm. broad, and lateral spinose cheeks with large eyes. The posterior or fifth segment is unlike the remaining cephalic segments and closely resembles those of the thorax; there is a threefold longitudinal subdivision into a central portion, showing a median sharp ridge, and two lateral portions each of which carries a backwardly directed furrow; the fifth segment no more than vaguely suggests a comparison with the occipital ring, the posterior border, and the pleuroccipital furrow of trilobites. The fourth cephalic segment is characteristic in shape because, as the paired third furrow is traced inwards from the lateral margin, it swings forwards on a convex curve, turns posteriorly as the mid line is approached, and ends in a hook-like extremity; the chevron-shaped median area, believed by Barrande to have morphological significance, may be accidental in origin, but it possesses much better-defined boundaries in the external mould, where it appears to send forward a prolongation on to the third segment, and assumes a spatulate shape. The third segment is bounded in front by the complete second furrow and shows two ridge-like tubercles one on each side of the mid-line. The second segment possesses a similar pair of elongated tubercles which lie immediately in front of those of the third segment; a marked reduction in the glabellar breadth occurs at the second glabellar furrow.[1] The frontal lobe is semicircular in shape and is defined posteriorly by the paired and incomplete first furrow; several cracks in the surface indicate that the lobe has been pressed down upon a narrow brim which appears to pass round the front.

The eye and most of the free cheek have been crushed and displaced relative to the glabella. A narrow band-like area with a marginal furrow occurs on the left of the posterior three glabellar segments and appears to be in place, but at the level of the second glabellar furrow and behind the eye this area is fractured across and slightly displaced outwards; thence the cheek and its attendant marginal furrow can be followed forwards, until it swings outwards and backwards as a narrow convex spine ornamented by terraced lines. For the most part the free cheek is thus reduced to a spine, a condition which recalls that found in *Deiphon*, where, however, the spine is carried on the fixed cheek. The portion of the cheek immediately in front of the eye is cracked, but it does not appear to be much disarranged; the anterior margin trends almost at right angles to the cranidial axis. The imperfectly preserved, coarsely faceted, and large eye extends back to the level of the second glabellar furrow and the posterior outline, as indicated by the concentric arrangement of the facets, is complete; although damaged anteriorly the left eye reaches as far forwards as the glabellar front, but is not seen to attain connexion in the mid-line with the right eye, a little of the faceted surface of which is preserved on the external mould. The facial suture, if present, remains undetected.

[1] Although a trilobite terminology is used for convenience in description, *Bohemilla* is now excluded from that group of arthropods (see p. 320).

Six free segments occur posterior to the cephalon, and, if the last is identified as the pygidium, the thorax comprises five segments, all of which exhibit the same general structure. Each is divided into three parts; the middle is about one-half of the total thoracic breadth, carries a median ridge, and is separated from the lobate lateral regions by oblique and posteriorly directed furrows of seemingly complicated shape. The sixth segment is incompletely preserved and possesses a similar structure; it may thus represent the last thoracic segment, in which case a minute bifid surface at the posterior tip of the specimen may be interpreted as a fragment of a pygidium of unknown shape.

Lectotype. Museum of Comparative Zoology 4404.

Horizon and locality. The lectotype is stated by Barrande as coming from the Dd_1 beds of St. Benigna, Bohemia; Klouček records the species only from the $D_{1\gamma b}$ beds, which under a recent notation have been relettered $D_{\gamma 2}$ and placed in the Llandeilo Series of the Ordovician (see p. 310).

Discussion. In addition to the lectotype there were three other specimens available to Barrande, and one of these he figured (1872: pl. 14, fig. 32; MCZ: 4405A); they are preserved in a flattened condition in dark shale and have assumed a variety of forms which suggest they do not belong to *B. stupenda*; alternatively, the differences separating them from that species, or even from the genus, are elusive and difficult to define. The three additional specimens provide material with which to compare *B. stupenda*, and the incomplete cranidium, identified as belonging to that species by Klouček and utilized by him to refute Beecher's statement that Barrande had misinterpreted the structure of the lectotype, is also available.

The glabella figured by Barrande (*vide supra* and Pl. 33, fig. 13) is different in shape from that of the lectotype, being more rounded anteriorly where it is less damaged by compression, but the reduction in glabellar breadth at the second furrow is absent. The number of glabellar segments, the tubercles on the second and third segments, and the median ridge on the last segment are the same, but the disposition of some of the glabellar furrows is not identical.

A more distorted and apparently broader specimen (MCZ: 4406; Pl. 33, fig. 14) has retained the posterior part of the lateral surface of the cheek and its furrow; the margin of the cheek sweeps forward in a manner consistent with that shown by the lectotype, but there is a definite reduction in glabellar breadth, followed by an expansion, immediately in front of the first furrow, while on the right side a palpebral lobe may face the second segment.

The third additional specimen is the worst preserved (MCZ: 4405B; Pl. 33, fig. 15); here the reduction and expansion in glabellar breadth referred to above are more noticeable, a palpebral lobe is suggested on the photograph, but the elongated tubercles on the glabellar segments cannot be detected.

The specimen used by Klouček is in relief (NM: CD 523; Pl. 33, fig. 16); it is a poorly preserved example of a mould of the under surface of a cranidium, and a ridge on the occipital ring and tubercles on the glabella are not visible; the glabellar furrows are slightly different in form from those of *Bohemilla*, the occipital ring is well defined, the glabella is constricted in front of the first furrow and then expands anteriorly; most important, a palpebral lobe arises at the side of the constriction of

the glabella, curves backwards and outwards and then turns inwards to meet the axial furrow near the middle of the second segment; the extreme anterior position of the palpebral lobe is unusual, but there is little doubt that this specimen is a trilobite.

The three forms studied by Barrande (MCZ: 4405A, 4405B, 4406) and the specimen attributed by Klouček to *B. stupenda* are in all probability members of the same species, but there is no real certainty that they can be placed in *Bohemilla*. The resemblances to *Bohemilla* are obvious, and accordingly misleading, but the anterior portion of the glabella and the form of the glabellar furrows are different in detail, and to identify these four specimens with *B. stupenda* is unsafe, particularly in view of their fragmentary condition. *B. stupenda* would thus be definitely represented only by the lectotype.

The only other occurrence of *Bohemilla* in Bohemia is from the Llanvirn Shales ($d_{\gamma 1}$) of Šárka. Novák identified a glabella associated with two thoracic pleurae as *B.* cf. *stupenda*, which Klouček (1919: 240) recorded, but did not figure, as *B. stupenda* var. *praecedens*; this differs from *B. stupenda* in possessing a broader front to the glabella.

Stubblefield (1939: 61) recognized the presence of *Bohemilla* among an Ashgillian fauna from co. Clare, Éire (Baily, 1862: 10, text-fig. 1*b*); because of the occurrence of *Dicellograptus complanatus* these beds can possibly be equated with the upper part of the Whitehouse Beds of Girvan, Ayrshire (Harper, 1942: 276).

Mrs. Gray recorded *Bohemilla* from the Whitehouse Beds of Ashgillian age of Whitehouse Bay, Girvan (*in* Peach & Horne, 1899: 517, 688), and Reed described the 'cranidia' but did not assign a specific name (1904: 53, pl. 8, fig. 4). Another and better preserved specimen was later obtained by Mrs. Gray and named *B. scotica* by Reed, who observed that this new species differs from *B. stupenda* particularly in the granulated ornament, in the shape of certain segments, and in the form of the furrows of the glabella (Reed, 1914: 22, pl. 4, fig. 1). I have recently exposed a further specimen (BM: In. 36987) which also demonstrates these differences and *B. scotica* can be accepted as an additional species which is also stratigraphically younger than *B. stupenda*.

Two specimens from Jämtland in Sweden were assigned by Linnarsson with great uncertainty to *Bohemilla* (*?*) *denticulata* (1875: 495, pl. 22, figs. 4, 5). Holm (1897: 457) re-examined the material, of which no new examples in the meantime had been collected, and, because Beecher (1896: 360) had produced reasons against the use of *Bohemilla* and hence Bohemillidae, he was constrained to place Linnarsson's specimens into known trilobite genera. Holm interpreted one specimen, showing large faceted eyes and what appear in Linnarsson's figures to be spines, as the underside of the head of *Aeglina*, and the pygidium, which was inaccurately illustrated, as a telephid. Whether Holm's new designations are correct, or not, is immaterial to the present study, because the specimens, incomplete and unsatisfactory as they are, are certain not to be retained in *Bohemilla*.

When reviewing the families and genera of trilobites Beecher found that *Bohemilla* was the only genus 'which could not be readily interpreted in terms of known trilobite morphology' (1896: 360), and he argued that the spinose cheek with its furrow and doublure was a part of the pygidial border which had become displaced. Beecher

drew a restoration of the lectotype, replaced the 'pygidium' (which in any case is too large for the individual), added to the thoracic segments a series of imaginary pleurae for which there is not a shred of evidence, and claimed that because two small faceted areas at each lateral margin of the fifth glabellar segment had been overlooked, the eyes in reality extended the whole length of the cephalon. A careful examination of the excellent stereoscopic photographs of the lectotype reveals no such faceted areas in those positions, while the concentric arrangement of the facets with the posterior border of the eye shows that that structure is undamaged posteriorly. Beecher was imbued with the idea that *Bohemilla* is a trilobite possessing morphological features which are foreign to the known anatomy of the group and he unjustifiably attempted to explain away the anomalies by converting the lectotype of *Bohemilla* into *Cyclopyge*. Holm (1897: 457), who did not have the opportunity of examining the types, supported Beecher, but the present study has only confirmed Barrande.

The assessment of *Bohemilla* as a trilobite must now be attempted. When describing *B. scotica*, Reed was forced to observe that this anomalous arthropod may in fact be an arachnid; and evidently Beecher felt that certain of the generic peculiarities were so abnormal that they had to be accounted for in one way or another, but mainly on the grounds of misleading and incomplete preservation, in order to retain the genus in the comity of trilobites. *Bohemilla*, however, finds no ready place among any known family and it is here excluded from the Trilobita by virtue of the following exoskeletal details: the anterior position of the spine of the so-called free cheek and its relation to the eye are atypical; the sudden reduction in glabellar breadth at the second furrow cannot be matched among trilobites and neither can the unusual trend of the third furrow; the paired tubercles on the second and third glabellar segments, the median chevron-shaped area on the third glabellar segment, and the median ridges on the fifth glabellar and on all the thoracic segments find no obvious parallel among trilobites; the absence of anything directly to be recognized as pleurae on the thoracic segments is a difference of fundamental importance. Having advanced reasons in favour of excluding *Bohemilla* from the Trilobita, a greater problem remains in finding a subdivision of the Arthropoda into which it can be accepted. Dr. H. E. Hinton, who kindly examined the photographs, said that he could perceive no diagnostic features which suggest comparison with any particular group of arthropods. The taxonomic position of *Bohemilla* thus remains unsolved, and it must rest for the moment as an example wherein the exoskeletal structures are, on the one hand, sufficient to exclude it from the Trilobita and, on the other hand, insufficient to provide that kind of evidence upon which the worker among modern arthropods relies in framing classifications.

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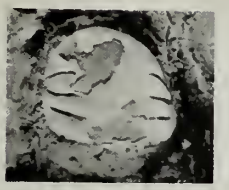

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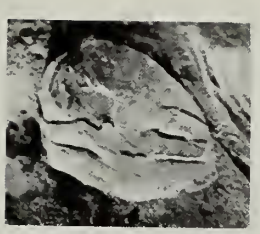

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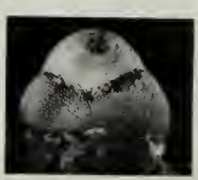

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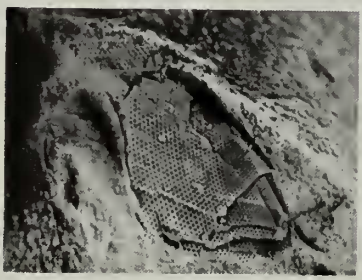

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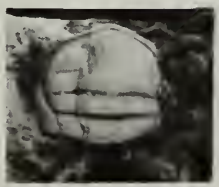

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PSILACELLA, PHYLACOPS, ELLIPSOTAPHRUS

Ellipsotaphrus pumilio gen. et sp. nov.

The specimens are from the Ordovician, Upper Whitehouse Beds, Ashgill Series: Whitehouse Bay, Girvan, Ayrshire.

Fig. 1. Internal mould of small individual to show glabellar furrows, occipital ring and short pleuroccipital furrow. Holotype. ×6. (BM: In. 41750.)

Fig. 2. Internal mould of larger individual showing general structure. ×6. (BM: In. 44001.)

Fig. 3. Internal mould. ×6. (BM: In. 21691.)

Ellipsotaphrus infaustus (Barrande)

Fig. 4. External mould of holotype showing occipital and pleuroccipital furrows in continuation with one another, and the fixed cheek. Caradoc Series, Cernin Beds ($Dd_{\epsilon 2a}$): Trubin, Bohemia. ×4. (NM: CD 855; photograph by National Museum, Prague.)

Fig. 5. Reproduction of Barrande's illustration of holotype (1852, pl. 34, fig. 45). ×4.

Cyclopygid pygidia

The specimens are from the Ordovician, Upper Whitehouse Beds, Ashgill Series: Whitehouse Bay, Girvan, Ayrshire.

Fig. 6. Pygidium, type *A*, which compares with *Symphysops subarmatus*. ×6. (BM: In. 42539.)

Fig. 7. Pygidium, type *B*, which compares with the specimen figured by Reed as *Cyclopyge rediviva* (1904, pl. 8, fig. 2). ×6. (BM: In. 21701.)

Fig. 8. Pygidium, type *C*, showing five axial rings and five pairs of pleurae, and axehead-shaped posterior area; this is probably a transitory pygidium. ×6. (BM: In. 44006.)

Fig. 9. Pygidium, type *C*, slightly larger than, but comparable with, the previous pygidium and showing four pronounced axial rings and four pairs of pleurae. ×6. (BM: In. 44110.)

Fig. 10. Pygidium, type *D*, showing seven or eight axial rings and five pairs of pleurae. ×6. (BM: In. 42548.)

Bohemilla stupenda Barrande

Fig. 11. Internal mould of lectotype to show general structure. Llandeilo Series (Dd_1 beds, now relettered $D_{\gamma 2}$): St. Benigna, Bohemia. ×1·5. (Schary Collection, MCZ: 4404; photograph by Prof. H. B. Whittington.)

Fig. 12. External mould of same individual. ×1·5. (Photograph by Prof. H. B. Whittington.)

Gen. indet.

Fig. 13. Internal mould of compressed cranidium, figured by Barrande (1872, pl. 14, fig. 32). ×3. Llandeilo Series (Dd_1 beds, relettered $D_{\gamma 2}$): St. Benigna, Bohemia. (Schary Collection, MCZ: 4405A; photograph by Prof. H. B. Whittington.)

Figs. 14, 15. Internal moulds studied, but unfigured, by Barrande. There is considerable doubt whether these incomplete and distorted cranidia (figs. 13–15) belong to *Bohemilla*; they show most similarity to the original of Fig. 16. Same locality and horizon. ×3. (fig. 14, Schary Collection, MCZ: 4406; fig. 15, MCZ: 4405B; photographs by Prof. H. B. Whittington.)

Fig. 16. The original specimen attributed by Klouček (1923) to *Bohemilla stupenda*; its nearest parallel is Fig. 14 and for the moment should be excluded from *Bohemilla*. Note the palpebral lobe on the right side. St. Benigna Beds ($Dd_{\gamma 2}$): Malé Přilepy, Bohemia. ×2. (NM: CD 523; photograph by National Museum, Prague.)

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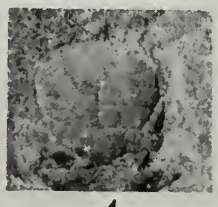

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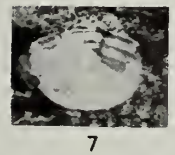

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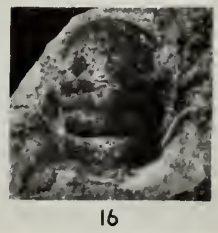

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ELLIPSOTAPHRUS, BOHEMILLA